3.4.2 Physical Habitat Conservation Measures

[***Note to Reviewers**: The text of this section of Chapter 3, including the physical habitat restoration conservation measures described, is subject to change and revision as the BDCP planning process progresses. This section, however, has been drafted and formatted to appear as it may in a draft HCP/NCCP. Although this section includes declarative statements (e.g., the Implementing Entity will…), it is nonetheless a "working draft" that will undergo further modification based on input from the BDCP Steering Committee, state and federal agencies, and the public.*

This section presently is focused on conservation measures directed toward species that use freshwater and brackish tidal marsh, subtidal riparian forest and scrub, and seasonally inundated floodplains. Measures to address species that use upland habitats and non-tidal wetlands are still in development and are not included in this draft.]

This section sets out the physical habitat conservation measures for the BDCP. It describes the approach to protecting, enhancing, and restoring (collectively referred to as "conserving") physical covered species habitats and the natural communities that support those habitats to help achieve the biological goals and objectives, as described in Table 3.2. Under the BDCP, these habitat areas will be managed in perpetuity to ensure that their intended ecological functions are maintained over the long-term.

The actions described in this section to conserve natural communities and habitats identified in Table 3.6 are expected to benefit a number of covered species. Descriptions of the covered species habitat types that are supported by these natural communities and habitats are presented in Appendix A, *Covered Species Accounts.*

The scope of the physical habitat actions provided for under the BDCP is presented in Table 3.7. The extent of the habitat and natural communities conservation actions set out in this section reflects both an assessment of the long-term conservation needs of individual covered species (i.e., habitat function, quantity, connectivity, and distribution), and an analysis of existing and future constraints that could affect habitat conservation, including land surface subsidence, habitat values, and land use.

A primary conservation goal of the BDCP is to restore 80,000 acres of tidal marsh and associated aquatic estuarine habitats, riparian habitat, and new floodplain for the benefit of fish, wildlife, and plants and ecosystem processes in the Delta and Suisun Marsh. The BDCP physical habitat conservation program is organized geographically across the northern, eastern, southern and western regions of the Delta. It is also organized by habitat type, and temporally into near-term and a long-term implementation phases. The schedule for protection, enhancement, and restoration of physical habitat is described in Chapter 6, *Implementation Plan*. Protection, enhancement, and restoration of other natural communities and habitats would be undertaken in both the near-term and long-term implementation periods as described in Chapter 6, *Implementation Plan*. In the near-term, prior to completion of the isolated conveyance facility, the BDCP targets for habitat restoration include 14,000 acres of tidal marsh and associated aquatic estuarine habitat and 1,300 acres of riparian forest and scrub habitat. Within 15 years, the goal is for tidal marsh and associated aquatic estuarine habitat restoration to reach 25,000 acres and riparian restoration to reach 2,300 acres and the addition of 1,000 acres of new season floodplain habitat. By year 40, the BDCP goal is to have established 65,000 acres of tidal marsh and associated aquatic estuarine habitats, 5,000 acres of riparian habitat, and 10,000 acres of new floodplain.[1]

[1] The 10,000 acre target for new floodplain restoration does not include floodplain habitat enhanced in the Yolo Bypass under WOCML2.

Table 3.6. Relationship of BDCP Covered Species to BDCP Protected, Enhanced, and Restored Natural Communities Expected to Provide Habitat Benefits

Covered Species	Protected, Enhanced, and Restored Natural Community and Habitat Types										
	Seasonally Inundated Floodplain	Freshwater Tidal Marsh	Brackish Tidal Marsh	Channel Margin	Riparian	Agricultural	Grassland	Natural Seasonal Wetland	Managed Seasonal Wetland	Nontidal Perennial Aquatic	Nontidal Permanent Emergent Marsh
Mammals											
San Joaquin kit fox							X				
Riparian woodrat					X						
Salt marsh harvest mouse		X	X								
Riparian brush rabbit					X						
Townsend's western big-eared bat					X						
Suisun shrew		X	X								
Birds											
Tricolored blackbird		X	X		X	X	X	X	X		X
Suisun song sparrow		X	X								
Yellow breasted chat				X	X						
Western burrowing owl						X	X	X	X		
Greater sandhill crane		X				X	X	X	X		
California black rail		X	X								
California clapper rail		X	X								
White-tailed kite				X	X	X	X	X	X		
Swainson's hawk				X	X	X	X	X	X		
Reptiles											
Giant garter snake		X				X	X	X	X	X	X
Western pond turtle		X		X	X		X			X	X
Amphibians											
California red-legged frog							X			X	X
Western spadefoot toad							X	X			
California tiger salamander, CV DPS							X	X		X	X
Fish											
Steelhead, Central Valley DPS	X	X	X	X							
Chinook Sacramento R. winter-run	X	X	X	X							
Chinook Central V. spring-run	X	X	X	X							
Chinook Central V. fall-/late fall-run	X	X	X	X							
Longfin smelt		X	X								
Delta smelt	X	X	X								
Sacramento splittail	X	X	X	X							
White sturgeon		X	X								
Green sturgeon		X	X								

Table 3.6. Relationship of BDCP Covered Species to BDCP Protected, Enhanced, and Restored Natural Communities Expected to Provide Habitat Benefits

Covered Species	*Protected, Enhanced, and Restored Natural Community and Habitat Types*										
	Seasonally Inundated Floodplain	**Freshwater Tidal Marsh**	**Brackish Tidal Marsh**	**Channel Margin**	**Riparian**	**Agricultural**	**Grassland**	**Natural Seasonal Wetland**	**Managed Seasonal Wetland**	**Nontidal Perennial Aquatic**	**Nontidal Permanent Emergent Marsh**
Fish (continued)											
Pacific lamprey		X	X	X							
River lamprey		X	X	X							
Invertebrates											
Valley elderberry longhorn beetle				X	X						
Vernal pool tadpole shrimp								X			
Conservancy fairy shrimp								X			
Longhorn fairy shrimp								X			
Vernal pool fairy shrimp								X			
Mid Valley Fairy Shrimp								X			
Plants											
Suisun Marsh aster (*Aster lentus*)		X	X	X	X						
Alkali milk-vetch								X			
Heartscale							X	X			
Brittlescale							X	X			
San Joaquin spearscale							X	X			
Lesser saltscale							X	X			
Slough thistle					X						
Suisun thistle			X								
Soft bird's-beak			X								
Delta button celery					X			X			
Boggs Lake hedge-hyssop								X			
Carquinez goldenbush			X				X	X			
Delta tule pea		X	X	X	X						
Legenere								X			
Heckard's peppergrass								X			
Mason's lilaeopsis		X	X	X	X						
Delta mudwort		X		X	X						
Caper-fruited tropidocarpum							X				

Notes:

1. This species habitat is supported by brackish tidal marsh. Freshwater tidal marsh restored in the west Delta, however, is anticipated to become brackish tidal marsh in the future with sea level rise.

Table 3.7. Extent of BDCP Natural Communities and Habitat Types Conserved Over the Term of the BDCP

Conserved Natural Community/Habitat Type	*Extent of Each Natural Community and Habitat Type Conserved*			
	Protected	**Enhanced (acres except as noted in table)**	**Restored**	**Total**
Seasonally Inundated Floodplain	[To come.]	2,000-6,000 cfs[1]	10,000 acres	[To come.]
Freshwater Tidal Marsh and Brackish Tidal Marsh	[To come.]	[To come.]	65,000 acres	[To come.]
Channel Margin	[To come.]	20 linear miles	[To come.]	[To come.]
Riparian	[To come.]	[To come.]	5,000 acres	[To come.]
Agricultural	[To come.]	[To come.]	[To come.]	[To come.]
Grassland	[To come.]	[To come.]	[To come.]	[To come.]
Natural Seasonal Wetland	[To come.]	[To come.]	[To come.]	[To come.]
Managed Seasonal Wetland	[To come.]	[To come.]	[To come.]	[To come.]
Nontidal Perennial Aquatic	[To come.]	[To come.]	[To come.]	[To come.]
Nontidal Permanent Emergent Marsh	[To come.]	[To come.]	[To come.]	[To come.]
Total	[To come.]	[To come.]	[To come.]	[To come.]

Notes:

1. This represents the extent of increased inflow into the existing Yolo Bypass floodplain that would be provided with operation of a modified Fremont Weir to increase the duration and frequency of seasonally inundated floodplain habitat. The conditions under which this increased inflow would be provided are described in conservation measure WOCML2 in Section 3.4.1.

In the near-term BDCP implementation period, actions to restore tidal marsh and riparian habitats will likely be directed at the Cache Slough, West Delta, and Suisun Marsh Restoration Opportunity Areas (ROAs) (see Figure 3.1). The initial focus on these ROAs reflects the anticipated productivity benefits that may be achieved in the near-term prior to changes to the existing through Delta conveyance system. These near-term elements of the habitat program will parallel adjustments in water management and flow regimes that are designed together to realize substantial improvements in aquatic productivity and function for covered species while the structural long-term improvements are constructed. Following commencement of dual water conveyance operations (i.e., the long-term BDCP implementation period), restoration of tidal and riparian habitat would continue in these ROAs and would be expanded significantly into the remaining ROAs in the south and eastern Delta. The restoration of physical habitat in tidal and floodplain areas will not only benefit covered species by the expansion of rearing and spawning habitat, but will also improve adjacent aquatic habitat through inputs of organic material and nutrients and through influences on hydrodynamics of flow and tidal action in upstream and downstream channels.

3.4.2.1 Physical Habitat Conservation Concepts

This section describes concepts associated with the protection, enhancement and restoration of habitat and natural communities present in the Planning Area and Suisun Marsh that support covered species. Under the BDCP, habitat protection refers to actions to ensure that lands that are intended to provide conservation values be used only for those purposes in perpetuity. Habitat restoration measures in the context of the BDCP are defined as those actions that either result in the reestablishment of habitat in historical locations or in the creation of habitat in areas where no such habitat previously existed. Habitat enhancement measures refer to improvements in the ecological functions of existing habitat. All areas that undergo habitat restoration or enhancement will either be in, or brought under, protected status.

Preserve Design Concepts

Important implementation concepts that will guide the selection, distribution and design of habitat protection, enhancement, and restoration are described below.

1. During the BDCP near-term implementation period, focus restoration and enhancement of covered fish species habitats in north Delta locations to generate improvements in productivity consistent with continued operations of the SWP and CVP pumping facilities.
2. Identify restoration areas and design actions to accommodate and integrate improvements in water management strategies over both the near-term and the long-term to optimize primary and secondary productivity, spawning and rearing, and other aquatic functions to support covered species.
3. During the BDCP long-term implementation period, expand the restoration and enhancement of habitats to include the Sacramento, Mokelumne, and San Joaquin River deltas to provide benefits to covered fish species found in each of those watersheds.
4. Design conservation measures for terrestrial and non-tidal wetland communities and covered wildlife and plants to complement the conservation strategies of approved and developing conservation plans for areas adjacent to and overlapping the BDCP planning area. These conservation measures will be implemented in coordination with the local government entities charged with the development and implementation of those plans, or equivalent program, in a manner that furthers their plan goals and objectives
5. Restore habitat in large patches to increase the likelihood of providing the desired levels of ecological function and to support large numbers of covered species.
6. Distribute restored and enhanced habitats throughout the Delta to minimize the risk of loss of substantial habitat benefits to catastrophic events in one part of the Delta.
7. Distribute and design restored habitats to withstand potential changes in Delta conditions associated with future sea level rise and changes in stream hydrographs.
8. Design tidal marsh habitats to withstand effects that could be associated with Delta levee failures.
9. Restore habitat in patch sizes that are equal to or greater than the patch sizes required by the covered species that use the habitat.
10. Juxtapose restored habitats with existing habitats to improve and maintain habitat corridors and connectivity among covered species habitats.
11. Locate and design restored habitats to provide beneficial hydrodynamic affects on adjacent channel systems (e.g., increased tidal flows that may result in decreased bidirectional flow in upstream channels or provide greater mixing in adjacent channels).
12. Locate and design restored habitats to create natural gradients in the Delta that historically transitioned from shallow subtidal aquatic habitats, to riverine floodplain habitats, and to transitional upland habitats (seasonal wetland, riparian, grassland).
13. Design tidal marsh and seasonally inundated floodplain habitats to provide access and egress to covered fish species such that fish do not become stranded or trapped.

14. Locate and design restored habitats to minimize potential effects of other stressors that could substantially degrade intended covered species benefits (e.g., effects of nearby diversions, discharges of low quality water).

15. Coordinate the design and management of wetland and aquatic habitat restorations and enhancements with mosquito abatement officials to incorporate to the extent practicable measures to reduce the likelihood for problem numbers of mosquitoes.

Site Selection

The BDCP has identified six ROAs within which tidal marsh habitat restoration and enhancement conservation measures designed to conserve covered fish species will be implemented (see Figure 3.1). Over the term of the BDCP, tidal marsh habitat for covered fish species may also be restored or enhanced in other locations within the Delta or outside the Delta in coordination with other conservation programs to further advance the BDCP biological goals and objectives. Protection, restoration, and enhancement of seasonal inundated floodplain, riparian, channel margin, terrestrial, and non-tidal wetland habitats may occur anywhere within the Planning Area and Suisun Marsh, including the tidal marsh ROAs, or in adjacent areas where physical habitat actions will contribute to the biological goals and objectives of adjacent or overlapping regional conservation plans.

Tidal marsh ROAs have been identified based on their suitability to support actions to restore or enhance tidal marsh habitat targeted by the plan and provide conditions beneficial to the conservation of the covered species. The primary criteria used to identify ROAs included land surface elevation relative to elevations that could support restored tidal marsh habitat, beneficial conditions for each of the covered fish species, geographic distribution to address the range of species within the Delta, practicability (e.g., cost, and potential effects on existing land uses and regional infrastructure), and previous restoration suitability assessments (e.g., CALFED Ecosystem Restoration Program actions and existing habitat restoration plans). Consequently, areas within the central Delta that are deeply subsided have generally been excluded from ROAs. ROAs encompass a total area of __ acres.

Before acquiring lands for habitat restoration and enhancement, the BDCP Implementing Entity will develop site selection criteria to evaluate the suitability of sites for habitat protection, enhancement, and restoration, and will collect sufficient site-specific information to make determinations pursuant to the criteria. Site selection criteria will include consideration of:

- presence of and proximity to existing occupied covered species habitats;
- connectivity to existing habitat areas;
- ability to complement achieving the goals and objectives of adjacent and overlapping regional conservation plans;
- potential for synergistically increasing covered species benefits with implementation of water operations and other stressors conservation measures;
- suitability for development of desired ecological functions and habitat characteristics (e.g., tidal connectivity, soil conditions, extent of area that could be restored as habitat);

- sustainability of restored habitat functions over time with future climate change and sea level rise;
- existing species and habitat values associated with evaluated sites;
- existing land uses and potential effects on surrounding land uses relative to other Delta locations;
- likelihood for creating mosquito vector control problems or nuisances relative to other Delta locations;
- proximity to infrastructure that could degrade restored habitat values (e.g., proximity to contaminant sources toxic to covered species or diversions that pose substantial risk for entrainment of covered fish species);
- relative suitability for restoring a mosaic of habitat types that would achieve multiple biological objectives;
- land acquisition and habitat restoration and maintenance costs; and
- site availability relative to the implementation schedule for protecting, enhancing, and restoring habitat.

Habitat Restoration Management Plans

The BDCP Implementing Entity will develop and implement specific habitat management plans for each conserved habitat area or assemblage of multiple connected or otherwise related habitat areas to guide long-term management. Habitat management plans will include the following information:

- biological goals and objectives to be addressed by the habitat, and how these tie back to the underlying goals and objectives of the BDCP;
- site-specific monitoring requirements and monitoring metrics by which to evaluate the achievement of the objectives for the plan and lay a foundation for adaptive management;
- areas for integration of management activities to ensure compatibility and synergistically increase benefits for covered species with implementation of water operations and other stressors conservation measures;
- non-native invasive plant species control requirements;
- non-native species predator and competitor control requirements;
- vegetation management activities;
- means for implementing the adaptive management program;
- infrastructure maintenance activities; and
- allowable uses and public access.

The BDCP Implementing Entity will maintain records of management activities and the results of associated monitoring for each habitat area. Habitat restoration management plans will periodically be revised to reflect any changes in management that are undertaken in response to results of monitoring and research.

3.4.2.2 Tidal Wetland, Riparian and Floodplain Restoration Conservation Measures

This section describes the habitat restoration conservation measures for tidal marsh, channel margin, riparian, and seasonally inundated floodplain habitats. Restoration of these habitat types is expected to contribute to the conservation of the covered fish, wildlife, and plant species by improving aquatic and wetland ecosystem functions and habitat conditions. Conservation measures to restore and enhance aquatic and wetland habitats have been evaluated through the DRERIP process. The potential benefits, uncertainties, and risks identified through the DRERIP evaluation process for each of the habitat conservation measures are presented in Appendix X, *DRERIP Evaluations.* Results of the DRERIP evaluations may be used by the Implementing Entity to design and implement restoration and enhancement actions to address uncertainties and minimize risks identified through the DRERIP process.

[***Note to Reviewers:*** *The naming convention for conservation measures (e.g., codes "HRCM1," "HRCM2") is retained here to allow for tracking of conservation measures through various changes, additions, deletions, and reorganizations over the past 1½ years of plan development. This approach to naming and numbering conservation measures has served its purpose and will be simplified as conservation measures become more stable in their form going into the administrative draft HCP/NCCP*].

Conservation Measures for Tidal Marsh Habitat: HRCM 16. Restore 65,000 acres of freshwater and brackish tidal marsh within Restoration Opportunity Areas. The BDCP will provide for the restoration of 65,000 acres of freshwater and brackish tidal marsh within the BDCP ROAs (Figure 3.1). For the purpose of this conservation measure, the acreage target for restored tidal marsh includes areas of subtidal habitat and transition upland habitat that form in association with the tidal marsh restoration action. The restoration or creation of this associated subtidal and transition upland habitat will be credited toward the overall target as follows:

- In areas of substantial land subsidence, subtidal aquatic habitat will constitute no greater than __% of the 65,000 acre target; and
- The transition upland habitat will comprise no greater than __% of the 65,000-acre total. This upland habitat will accommodate approximately 3 feet of sea level rise such that it will function as tidal marsh habitat at some future time. Additional upland habitat, however, would be protected and enhanced to provide habitat for terrestrial species.

Of the 65,000-acre restoration target, 22,000 acres will be distributed among the ROAs as described below in *Minimum Restoration Targets for Freshwater Tidal Marsh Habitat in ROAs* and *Minimum Restoration Target for Brackish Tidal Marsh Habitat in Suisun ROA.* The remaining 43,000 acres within the target total will be distributed among the ROA's at the discretion of the Implementing Entity based on land availability, biological value, and practicability considerations. The freshwater and brackish tidal marsh restoration targets will be achieved on the following time schedule:

- 14,000 acres developed[2] within the first 10 years of plan implementation;

[2] In achieving these targets the term "developed" means the completion of reintroduction of tidal inundation to areas expected to develop as tidal marsh. These target values represent the habitat area developed at the points in time identified. Development of fully functioning restored habitat may take years subsequent to initial tidal inundation through the effects of natural processes on the constructed surface.

- 25,000 acres (cumulative) developed by year 15 of plan implementation; and
- 65,000 acres (cumulative) developed by year 40 of plan implementation.

Freshwater Tidal Marsh Habitat Restoration. Freshwater tidal marsh habitats will be restored and enhanced to provide the following ecological benefits for covered fish species (see Appendix X, *DRERIP Evaluations*):

- increased primary and secondary production within restored tidal marsh channels in support of food production for covered fish species;
- export of organic carbon and primary and secondary production from restored marsh into Delta waterways in support of food production for covered fish species within and downstream of the Delta;
- improved covered fish species habitat conditions within tidal marsh channels and adjacent open water by reducing summer and fall water temperatures through nocturnal tidal thermal exchanges on marsh plain surfaces and reintroduction of cooled water to delta waterways;
- reduction of contaminants through filtering contaminants from Delta waterways or chemical transformation of contaminants to less toxic or non-toxic substances;
- increase in Sacramento splittail spawning and rearing habitat and salmonid and sturgeon rearing habitat associated with restoration of new tidal channels and shallow subtidal habitats adjacent to vegetated marsh plains;
- improved delta smelt and longfin smelt spawning habitat conditions;
- increased foraging habitat for white-tailed kite;
- increased breeding and foraging habitat for tricolored blackbird, Suisun song sparrow, and California black rail;
- increased aquatic and cover habitat for giant garter snake and western pond turtle; and
- increased habitat for Suisun Marsh aster, soft-bird's beak, delta tule pea, Mason's lilaeopsis, delta button celery, and delta mudwort where tidal marsh is restored within the range of each of these species and within the potential future range of soft-bird's beak given estimates of sea level rise and salinity intrusion.

Freshwater tidal marsh habitats will be restored by breaching or removing levees along Delta waterways to reestablish tidal connectivity to reclaimed lands. Tidal marsh restored on deeply subsided Delta tracts and islands may require construction of cross levees or berms to isolate deeply subsided lands from inundation, avoiding the creation of large areas of subtidal habitats that could favor non-native predator/competitor species and disfavor covered fish species. Where required, levees or berms will be constructed to prevent inundation of adjacent lands. Where appropriate and feasible, portions of restoration sites will be raised to elevations that support tidal marsh vegetation. Depending on the degree of subsidence and location, lands may be elevated by grading higher elevations to fill subsided areas, importing dredged or fill material from other locations, or planting tules or other appropriate vegetation to raise elevations in shallowly subsided areas over time through organic material accumulation. Surface grading will provide for a shallow elevation gradient from the marsh plain to the upland transition habitat. Based on assessments of local hydrodynamic conditions, sediment transport, and topography,

restoration activities may be designed and implemented in a manner that accelerates the development of tidal channels within restored marshes. Following reintroduction of tidal exchange, tidal marsh vegetation will likely become established naturally at suitable elevations relative to the tidal range. Tidal marsh restoration sites will be monitored to determine if enhancement of tidal marsh vegetation could occur through artificial installation of patches of native emergent vegetation (see specific monitoring requirements with each conservation measure).

Restoration variables that will be considered in the design of restored freshwater tidal marsh habitat include:

- spatial distribution of restored tidal marsh habitats within the Delta;
- extent, location, and configuration of restored tidal marsh habitat areas;
- predicted tidal range at tidal marsh restoration sites following reintroduction of tidal exchange;
- size and location of levee breaches;
- cross sectional profile of tidal marsh restoration sites (elevation of marsh plain, topographic diversity, depth, and slope); and
- density and size of tidal marsh channels appropriate to each restoration site.

Restored freshwater tidal habitats will be designed to support habitat for covered species listed in Table 3.6. Restoration design considerations for freshwater tidal marsh habitat will include the following.

Marsh Plain Vegetation. To provide for highly functioning habitat, restored tidal marsh plains will be vegetated primarily with tules and other native freshwater emergent vegetation to reflect the historical composition and densities of Delta tidal marshes.

Hydrodynamic Conditions. Tidal marsh restoration will be designed to produce sinuous, high density, dendritic networks of tidal channels that promote effective tidal exchange throughout the marsh plain. Effective tidal exchange will enhance ecological functions that support covered fish species, including:

- the export of productivity from the marsh plain into adjacent Delta waterways in support of aquatic food web processes;
- production and export of phytoplankton and zooplankton from tidal channels into adjacent Delta waterways in support of the aquatic food web;
- filtration and chemical transformation of contaminants from tidally exchanged water; and
- maintenance of cooler localized water temperatures preferred by covered fish species through nocturnal thermal exchange on marsh plains.

Marsh channels and levee breaches will also be designed to maintain flow velocities that minimize conditions favorable to the establishment of non-native submerged and floating aquatic vegetation and habitat for non-native predatory fish.

Environmental Gradients. To the extent practicable as determined by site-specific constraints, tidal marsh restoration actions will be designed to provide a natural ecological gradient among subtidal, tidal, riparian, and upland habitats to accommodate the movement of fish and wildlife species and provide flood refuge habitat for marsh-associated species during high water events. In addition, by protecting higher elevation lands adjacent to restored marsh plains, areas will later be available for marsh establishment that may occur as a result of sea level rise associated with climate change. Higher elevation lands protected in anticipation of changing distributions of habitats with sea level rise are referred to as "accommodation space."

Shallow subtidal aquatic habitat. Shallow freshwater subtidal aquatic habitat in some portions of the Delta support large numbers of non-native predatory fish and extensive beds of non-native submerged aquatic and floating vegetation that adversely affect covered fish species. Because it would generate habitat for non-native predators, the BDCP does not include measures to restore areas of shallow subtidal aquatic habitat; rather, shallow subtidal aquatic habitat may form as a result of the restoration of freshwater tidal marsh where land surface elevations within restoration sites are subsided below elevations that would support tidal marsh. Tidal marsh restoration projects will be designed to minimize the likelihood of establishment of non-native submerged aquatic and floating vegetation, which may serve as habitat for non-native predators. Early restoration projects will be monitored to assess the response of non-native species to restoration designs and local environmental conditions. This information will be used to modify restoration designs and implementation methods, if necessary, over time to further improve habitat conditions for covered fish species. As described in OSCM13 *Remove Non-Native Submerged and Floating Aquatic Vegetation from Delta Waterways*, the BDCP Implementing Entity will engage in active removal of submerged aquatic and float aquatic vegetation in subtidal portions of tidal restoration sites to reduce the levels of establishment of non-native predators.

Boat wake reduction. Boat wake-induced disturbance of restored marsh habitats may limit the establishment and sustainability of native freshwater emergent vegetation in restored habitat areas. The BDCP Implementing Entity will coordinate with and fund the Department of Boating and Waterways and local governing entities to establish low boat speed regulations (no wake zones) and post signs in Delta locations with restored tidal marsh and shallow subtidal habitat that has been. Low boat speed zones would only be established in locations where the ecological functions of restored tidal marsh and adjacent shallow subtidal aquatic habitats could be degraded by boat wakes.

Minimum Restoration Targets for Freshwater Tidal Marsh Habitat in ROAs. The BDCP Implementing Entity will restore a minimum of freshwater tidal marsh in each of the ROAs (see Figure 3.1) as follows:

- **HRCM4: Restore at least 5,000 acres freshwater tidal marsh within the Cache Slough Complex ROA**. The BDCP Implementing Entity will restore a minimum of 5,000 acres of freshwater tidal marsh in the Cache Slough Complex ROA. Areas suitable for restoration include, but are not limited to, Haas Slough, Hastings Cut, Lindsey Slough, Barker Slough, Calhoun Cut, Liberty Island, Little Holland, the Westlands property, Shag Slough, Little Egbert Tract, and Prospect Island. The Cache Slough Complex has been recognized as possibly the best functioning tidal habitat area of the Delta. The complex includes Liberty Island, which is likely the best model for freshwater

tidal marsh restoration in the Delta for native fishes. The Complex supports multiple covered fish species and is presumably one of the last known areas where Delta smelt and longfin smelt spawn and rear successfully. Restoring the amount of freshwater tidal wetlands and subtidal habitat and protecting upland habitat could benefit multiple covered species and the Delta ecosystem. Additionally, the Cache Slough Complex encompasses a substantial area of land with elevations suitable for freshwater tidal marsh restoration that would involve few impacts on infrastructure or permanent crops relative to other areas of the north Delta. The Cache Slough Complex provides an excellent opportunity to expand habitat supporting multiple aquatic and terrestrial covered species. Restoration of freshwater intertidal marsh and shallow subtidal habitats would be designed to support the physical and biological attributes that benefit covered species. Based on existing land elevations, approximately 21,000 acres of public and private lands in the area are potentially suitable for restoration of tidal marsh. Areas for restoration would be identified by working with interested landowners.

- **HRCM5: Restore at least 1,500 acres of freshwater tidal marsh within the Cosumnes/Mokelumne ROA**. The BDCP Implementing Entity will restore a minimum of 1,500 acres of freshwater tidal marsh in the Cosumnes/Mokelumne ROA. Areas suitable for restoration within the Cosumnes/Mokelumne ROA (see Figure 3.1) include McCormack-Williamson Tract, New Hope Tract, Canal Ranch Tract, Bract Tract, Terminous Tract north of State Highway 12, and lands adjoining Snodgrass Slough, South Stone Lake, and Lost Slough. If an eastern alignment around-Delta canal conveyance facility is constructed, the canal levees may be incorporated into the design of tidal marsh restoration. For example, in locations where the conveyance canal is located at elevations at or below elevations suitable for restoration of tidal marsh, marsh may be restored to the east of the canal levee, with the canal levee forming the western boundary of the restored tidal marsh.

- **HRCM6: Restore at least 2,100 acres of tidal marsh within the West Delta ROA.** The BDCP Implementing Entity will restore a minimum of 2,100 acres of freshwater tidal marsh in the West Delta ROA. The west Delta includes multiple small areas where tidal marsh, can be restored. Areas suitable for restoration include Dutch Slough, Decker Island, portions of Sherman Island, Jersey Island, Bradford Island, Twitchell Island, Brannon Island, Grand Island, and along portions of the north bank of the Sacramento River where elevations and substrates are suitable. The purpose of restoring tidal marsh in the west Delta is to provide a continuous reach of tidal marsh and aquatic habitat associated with food productivity between current and future restored habitats in the Cache Slough Complex and Suisun Marsh and Bay and to provide tidal marsh habitat within the anticipated future eastward position of the low salinity zone with sea level rise.

- **HRCM7: Restore at least 5,000 acres of tidal marsh within the South Delta ROA.** The BDCP Implementing Entity will restore a minimum of 5,000 acres of freshwater tidal marsh in the South Delta ROA. Potential sites for restoring freshwater tidal marsh include Fabian Tract, Union Island, Middle Roberts Island, and Lower Roberts Island. Sites selected for restoration would be dependent on the location and design of the selected conveyance pathway and operations for the through-Delta component of the dual conveyance facility. Selected sites would be those that would provide substantial species

and ecosystem benefits with the selected through-Delta conveyance configuration and most effectively avoid adverse affects of south Delta SWP/CVP operations.

- **HRCM8: Restore at least 1,400 acres tidal marsh within the East Delta ROA.** The BDCP Implementing Entity will restore a minimum of 1,400 acres of freshwater tidal marsh in the East Delta ROA. Areas suitable for restoration in the East Delta ROA (see Figure 3.1) include Terminous Tract south of State Highway 12, Shin Kee Tract, Rio Blanco Tract, and Bishop Bract. If an eastern alignment of an around-Delta canal conveyance facility is constructed, the canal levees may be incorporated into the design of intertidal emergent wetland restoration. For example, in locations where the conveyance canal is located at elevations at or below elevations suitable for restoration of intertidal marsh, marsh may be restored to the east of canal levee, with the canal levee forming the western boundary of the restored marsh.

Restored freshwater tidal marsh will be designed to support the physical and biological attributes described in above in *Freshwater Tidal Marsh Habitat Restoration*. Restored tidal marshes will be designed to support a mosaic of tidal marsh, tide flat, shallow subtidal aquatic, and transitional upland and riparian habitats as appropriate to specific restoration sites to mimic the historical ecological gradients of the Delta.

Design elements of freshwater tidal marsh restoration will include:

- acquiring lands, in fee-title or through conservation easements, suitable for restoration of intertidal and subtidal habitats and protecting adjacent uplands to accommodate future sea level rise;
- acquiring lands, in fee-title or through conservation easements, with transition habitat and upland habitat adjacent to restored tidelands sufficient to accommodate future sea level rise;
- breaching levees to reintroduce tidal exchange and restore tidal marsh to currently leveed former tidelands**;**
- constructing new or enhancing existing levees to provide flood protection for adjacent landowners and protecting existing land use against seepage and erosion of existing levees;
- constructing new levees to isolate deeply subsided lands for tidal flooding;
- excavating channels and creating berms to encourage the development of dendritic channel networks within restored marshes;
- modifying ditches, cuts, and levees to encourage more natural tidal circulation and better flood conveyance based on local hydrology;
- restoring tributary stream functions to establish more natural patterns of sediment transport to improve spawning conditions for delta smelt and other fish and macroinvertebrates;
- prior to breaching, scalping higher elevation land to provide fill for placement on subsided lands to raise surface elevations suitable for establishment of marsh plain in the intertidal zone;

- prior to breaching, importing dredge or fill in shallowly subsided areas to raise ground surface elevations to a level suitable for establishment of marsh plain in the intertidal zone;
- prior to breaching, planting tules in shallowly subsided areas to provide established marsh patches to accelerate marsh expansion and surface accretion following flooding;
- prior to breaching, farming tules for long periods to raise subsided ground surface to elevations suitable to support intertidal marsh and breaching levees when target elevations are achieved; and
- designing levee breaches to maximize the development of intertidal marsh and minimize hydrodynamic conditions that favor non-native predatory fish.

Problem Statement: The majority of historical freshwater and brackish tidal marsh in the Sacramento/San Joaquin Delta and Suisun Bay system has been lost. Historically, approximately 350,000 acres of tidal marsh was present in the Delta and 67,000 acres in Suisun Marsh. Approximately 10,000 acres of tidal marsh remain in the Delta (freshwater) and 8,300 acres in Suisun Marsh (brackish). This loss of tidal marsh has greatly reduced the availability and quality of spawning and rearing habitat for many native species, by reducing the input of organic and inorganic material and food resources into adjoining deep water habitats (sloughs and channels) and the downstream bay and estuary.

Hypotheses: Restoration of freshwater tidal marsh and shallow subtidal aquatic habitats are hypothesized to provide a range of ecosystem and covered species benefits. These anticipated benefits are described below for the freshwater tidal marsh restoration proposed in each of the ROAs. As described in Appendix X, *DRERIP Evaluations*, however, there are a number of uncertainties regarding the level of benefits that may be provided by marsh restored in each of the ROAs as well as risks for adverse consequences.

Restoring freshwater intertidal marsh and shallow subtidal aquatic habitats within the Cache Slough ROA will:

- increase rearing habitat area for Chinook salmon, Sacramento splittail, white sturgeon, and green sturgeon (Healey 1991, Brown 2003, Appendix X, *DRERIP Evaluations*);
- increase the local production of food for rearing salmonids, splittail, delta smelt, green and white sturgeon (Kjelson et al. 1982, Siegel 2007);
- increase the export of food in the Delta downstream of Rio Vista available to juvenile salmonids, splittail, delta smelt, white sturgeon, and green sturgeon by exporting organic material from the marsh plain and phytoplankton, zooplankton, and other organisms produced in intertidal channels into the Delta and Suisun Marsh (Siegel 2007);
- expand areas of cool water refugia for delta smelt (C. Enright pers. comm.);
- expand habitat available for colonization by Mason's lilaeopsis; and
- expand habitat for giant garter snake, California black rail, and tricolored blackbird.

In conjunction with floodplain enhancement in the Yolo Bypass, the habitat restoration in the Cache Slough ROA will re-establish the ecological gradient from river to floodplain to tidal estuary and to provide intertidal wetland adjacent to open channel habitat that is characteristic of less altered estuaries. Preliminary hydrodynamic modeling indicates that increased tidal exchange in the Cache Slough area resulting from 5,000-10,000 acres of tidal marsh restoration will reduce bidirectional flows in Steamboat and Sutter Sloughs and the mainstem Sacramento River associated with tidal action under present conditions, thus significantly enhancing movement of juvenile salmonids through these waterways and potentially reducing their exposure to predators.

Restoring freshwater intertidal marsh and shallow subtidal aquatic habitats within the Cosumnes/Mokelumne River ROA is also believed to reduce the adverse effects of stressors on the availability of food and habitat for the covered fish species by:

- increasing rearing habitat area for Cosumnes/Mokelumne fall-run Chinook salmon, steelhead, delta smelt, and Sacramento splittail (Healey 1991, Brown 2003);
- increasing the local production of food for Cosumnes/Mokelumne fall-run Chinook salmon, steelhead, delta smelt, and Sacramento splittail migrating to and from the Cosumnes and Mokelumne Rivers (Kjelson et al. 1982, Siegel 2007);
- increasing the availability and production of food in the east and central Delta available to juvenile salmonids, splittail, delta smelt, white sturgeon, and green sturgeon by exporting organic material from the marsh plain and phytoplankton, zooplankton, and other organisms produced in intertidal channels into the Delta (Siegel 2007);
- locally providing areas of cool water refugia for delta smelt (C. Enright pers. comm.);
- increasing the extent of habitat available for colonization by Mason's lilaeopsis, and
- increasing the extent of habitat for giant garter snake, California black rail, and tricolored blackbird.
- Restoring freshwater intertidal marsh and shallow subtidal aquatic habitats in the West Delta ROA is also believed to reduce the adverse effects of stressors related to food and habitat availability for the covered species by:
- increasing rearing habitat area for Chinook salmon, Sacramento splittail, and possibly steelhead (Healey 1991, Brown 2003);
- improving future rearing habitat areas for delta smelt and longfin smelt within the anticipated eastward movement of the low salinity zone with sea level rise. Lands within the West Delta ROA (see Figure 3.1) represent the only location to implement intertidal marsh restoration within the anticipated future location of the low salinity zone with sea level rise;
- increasing the local production of food for rearing salmonids, splittail, and other covered species (Kjelson et al. 1982; Siegel 2007);
- increasing the availability and production of food in the western Delta and Suisun Bay by exporting organic material via tidal flow from the marsh plain and organic

carbon, phytoplankton, zooplankton, and other organisms produced in intertidal channels into adjacent open water areas (Siegel 2007);

- providing an important linkage between current and future upstream restored habitat with downstream habitat in Suisun Marsh and Bay. This area's location at the confluence of the Sacramento and San Joaquin Rivers make it uniquely important to improving connectivity among the communities and species of the Delta;
- providing additional refugial habitat for migrating and resident covered species;
- locally providing areas of cool water refugia for delta smelt (C. Enright pers. comm.);
- increasing the extent of habitat available for colonization by Mason's lilaeopsis; and
- increasing the extent of habitat for California black rail and tricolored blackbird.
- Restoring freshwater intertidal marsh and shallow subtidal aquatic habitats in the South Delta ROA will reduce the adverse effects of stressors related to the availability of food and habitat for the covered species by:
- increasing rearing habitat area for Sacramento splittail, Chinook salmon produced in the San Joaquin River and other eastside tributaries, and possibly steelhead (Healey 1991, Brown 2003);
- increasing the local production of food for rearing salmonids, splittail, and other covered species (Kjelson et al. 1982; Siegel 2007);
- increasing the availability and production of food in the Delta and Suisun Bay by export from the south Delta of organic material via tidal flow from the new marsh plain and organic carbon, phytoplankton, zooplankton, and other organisms produced in new intertidal channels (Siegel 2007);
- locally providing areas of cool water refugia for delta smelt (C. Enright pers. comm.);
- increasing the extent of habitat available for colonization by Mason's lilaeopsis; and
- increasing the extent of habitat for California black rail and tricolored blackbird.

Additionally, in conjunction with dual conveyance operations, marsh restoration in the South Delta ROA may support the expansion of the current distribution of delta smelt into formerly occupied habitat areas.

Restoring freshwater intertidal marsh and shallow subtidal aquatic habitats within the East Delta ROA is also believed to reduce the adverse effects of stressors related to food and habitat availability for the covered fish species by:

- increasing rearing habitat area for Sacramento splittail and San Joaquin Chinook salmon and possibly steelhead (Healey 1991, Brown 2003);
- increasing the local production of food for rearing salmonids, splittail, and other covered species (Kjelson et al. 1982, Siegel 2007);
- increasing the availability and production of food in the east and central Delta by exporting organic material from the marsh plain and phytoplankton, zooplankton, and other organisms produced in intertidal channels into the Delta (Siegel 2007);

- locally providing areas of cool water refugia for delta smelt (C. Enright pers. comm.);
- increasing the extent of habitat available for colonization by Mason's lilaeopsis, and
- increasing the extent of habitat for giant garter snake, California black rail, and tricolored blackbird.

Adaptive management considerations: The adaptive management program will assess the value of restored marshes and adjacent shallow subtidal habitats to covered species habitat, including the capacity of the restored areas to produce food and organic carbon to support food web processes. Results of monitoring the development of early marsh restorations will help inform the design and management of subsequent marsh restoration projects. In addition, monitoring results will also support the development of more cost effective management techniques, if needed, to control the establishment of non-native species in restored marshes.

Brackish Tidal Marsh Habitat Restoration. Brackish tidal marsh will be restored within Suisun Marsh in coordination with the Suisun Marsh Habitat Restoration and Management Plan, currently under development. Brackish tidal marsh habitats will be restored and enhanced to provide the following ecological benefits for covered species (see Appendix X, *DRERIP Evaluations*):

- increased primary and secondary production within restored tidal marsh channels in support of food production for covered fish species;
- export of production from brackish tidal marsh into open water of Suisun Marsh sloughs and Suisun Bay in support of food for covered fish species, including delta and longfin smelt;
- improved covered fish species habitat conditions within tidal marsh channels and adjacent open water by reducing summer/fall water temperature through nocturnal tidal thermal exchange on marsh plain surfaces and reintroduction of cooled water to Suisun Marsh sloughs and Suisun Bay;
- reduction of contaminants through filtering contaminants from Suisun Bay or chemical transformation of contaminants to less toxic/non-toxic substances;
- increase in Sacramento splittail spawning and rearing habitat and salmonid and sturgeon rearing habitat associated with restoration of new tidal channels and shallow subtidal habitats adjacent to vegetated marsh plains;
- improved delta smelt and longfin smelt habitat conditions in Suisun Marsh sloughs and Suisun Bay;
- increased habitat for salt marsh harvest mouse, Suisun shrew, California black rail, and California clapper rail;
- increased foraging habitat for white-tailed kite;
- increased breeding habitat for tricolored blackbird, Suisun song sparrow;
- increased aquatic and cover habitat for western pond turtle; and
- increased habitat for Suisun Marsh aster, soft bird's-beak, Delta tule pea, and Mason's lilaeopsis where brackish tidal marsh is restored within the range of each of these species.

Brackish tidal marsh habitats will be restored by breaching or removing dikes along Montezuma and other Suisun Marsh sloughs and channels and Suisun Bay to reestablish tidal connectivity to reclaimed lands. Tidal marsh restored adjacent to farmed lands or lands managed as freshwater seasonal wetlands may require construction of dikes to maintain those land uses. Where appropriate, portions of restoration sites will be graded to elevations that would support tidal marsh vegetation. Depending on the degree of subsidence, location, and likelihood for natural accretion through sedimentation, lands may be elevated by grading higher elevations to fill subsided areas, importing dredged or fill material from other locations, or planting tules or other appropriate vegetation to raise elevations in shallowly subsided areas over time through organic material accumulation. Surface grading will be designed to result in a shallow elevation gradient from the marsh plain to the upland transition habitat. Remnant disconnected tidal channels would be restored if present within restoration sites to accelerate development of marsh functions. Based on assessments of local hydrodynamic conditions, sediment transport, and topography, restoration sites may be graded to accelerate the development of tidal channels within restored marshes. Following reintroduction of tidal exchange, tidal marsh vegetation would be expected to naturally establish at suitable elevations relative to the tidal range. Tidal marsh restoration sites will be monitored to determine if development of tidal marsh vegetation and functions would be enhanced with plantings of native emergent vegetation (see specific monitoring requirements with each conservation measure).

- Variables that will be considered in the design of restorations actions for brackish tidal marsh habitat include the:
- extent, location, and configuration of restored tidal marsh habitat areas,
- distribution of restored marshes along salinity gradients to optimize the range of habitat conditions for covered species and food production;
- predicted tidal range at tidal marsh restoration sites following reintroduction of tidal exchange;
- size and location of dike breaches;
- cross sectional profile of tidal marsh restoration sites (elevation of marsh plain, topographic diversity, depth, and slope); and
- density and size of tidal marsh channels appropriate to each restoration site.

Restoration actions for brackish tidal habitats will be designed to support habitat for covered species listed in Table 3.6. Restoration design considerations for brackish tidal marsh habitat include the following.

Marsh Plain Vegetation. To provide high functioning habitat, restored tidal marsh plains will be dominated by native brackish marsh vegetation (e.g., pickleweed, saltgrass) appropriate to marsh plain elevations, mimicking the composition and densities of historical Suisun Bay brackish tidal marshes. Vegetated marsh plains will also be expected to filter non-point source pollution from surface or subsurface infiltration that otherwise would flow into Suisun Bay.

Hydrodynamic Conditions. Restored brackish tidal marshes will be designed to provide hydrodynamic conditions similar to those described for freshwater tidal marsh.

Environmental Gradients. To the extent practicable as determined by site-specific constraints, restored tidal marshes will be designed to provide a natural ecological gradient among subtidal, tidal, and upland habitats to accommodate movement of fish and wildlife species and provide flood refuge habitat for marsh-associated species during high water events. Because land surface elevations within Suisun Marsh are relatively homogenous, opportunities to provide linkages to upland habitats are limited to restoration sites that are located along the fringe of Suisun Marsh. Dikes constructed to restore marshes in the interior of Suisun Marsh will be designed with low gradient slopes supporting high marsh and upland vegetation to provide flood refuge habitat. Where appropriate, higher elevation islands of upland habitat within restored marshes may also be created to provide flood refuge for marsh wildlife.

Minimum Restoration Targets for Brackish Tidal Marsh Habitat in Suisun ROA. The BDCP Implementing Entity will restore a minimum of freshwater tidal marsh in the Suisun Marsh ROA as follows:

- **HRCM9: Restore at least 7,000 acres of brackish tidal marsh within the Suisun Marsh Restoration Opportunity Area.** The BDCP Implementing Entity will restore a minimum of 7,000 acres of brackish tidal marsh in the Suisun Marsh ROA. Restored brackish tidal marsh will be designed to support the physical and biological attributes described in above in *Brackish Tidal Marsh Habitat Restoration*. Restored tidal marshes will be designed to support a mosaic of tidal marsh, tide flat, shallow subtidal aquatic, and transitional upland habitats as appropriate to specific restoration sites to mimic the historical ecological gradients of Suisun Marsh and Bay. The Suisun Marsh ROA (Figure 3.1) encompasses a substantial area with elevations suitable for intertidal marsh restoration that would have minimal effect on infrastructure or permanent crops relative to other suitable lands within the Delta.

The Suisun Marsh Habitat Management, Preservation, and Restoration Plan (currently under development) will include an evaluation of alternatives, including options that contemplate the restoration of up to 7,000 acres of brackish tidal marsh. Much of Suisun Marsh is currently at elevations that could be restored to tidal habitat.

Anticipated actions to restore brackish intertidal marsh habitat include:

- acquisition of lands, in fee-title or through conservation easements, suitable for restoration of intertidal and subtidal habitats and for accommodating future sea level rise from willing landowners;
- reconnecting disconnected remnant sloughs to Suisun Bay and removing remnant slough dikes to reintroduce tidal connectivity to slough watersheds to restore tidal marsh; and
- breaching dikes to reintroduce tidal exchange to diked lands.
- excavating channels and creating berms to encourage the development of dendritic channel networks within restored marshes;
- modifying ditches, cuts, and levees to encourage more natural tidal circulation and better flood conveyance based on local hydrology;

- prior to breaching, scalping higher elevation portions of islands to provide fill for placement on subsided lands to raise surface elevations suitable for establishment of marsh plain in the intertidal zone;
- prior to breaching, importing dredge or fill in shallowly subsided areas to raise ground surface elevations to a level suitable for establishment of marsh plain in the intertidal zone;

Hydrodynamic modeling conducted for the Suisun Marsh Restoration Plan (J. DeGeorge pers. comm.) indicates that restoring marsh north of Montezuma Slough would shift the low salinity zone westward and restoring marsh at sites adjacent to Suisun Bay would shift the low salinity zone eastward, potentially adversely affecting delta smelt habitat and water quality in the west Delta. Consequently, implementation of marsh restoration projects in north and south Suisun Marsh will likely be sequenced such that these potential effects would be minimized.

As described in WOCML11, future reoperation or removal of the Montezuma Slough Salinity Control Gate will increase the benefits of restoring brackish intertidal marsh in Suisun Marsh by increasing access for covered fish species to existing and restored tidal aquatic habitat within a large area of Suisun Marsh.

Problem Statement: Suisun Marsh is the largest brackish water marsh complex in the Western United States. It supports many listed and sensitive terrestrial and aquatic species. Much of the marsh currently is diked to prevent tidal influence and is managed as seasonal wetlands for waterfowl (approximately 52,000 acres). The majority of the Suisun Marsh is owned privately or by the Department of Fish and Game and is protected under the Suisun Marsh Preservation Act. Restoration of a portion of these diked marshes to tidal influence is being planned under the Suisun Marsh Restoration and Management Plan.

Hypotheses: Restoration of brackish tidal marsh and shallow subtidal aquatic habitats in Suisun Marsh are hypothesized to provide a range of ecosystem and covered species benefits. As described in Appendix X, *DRERIP Evaluations*, however, there are a number of uncertainties regarding the level of benefits that may be provided by marsh restored as well as risks for adverse consequences. Restoring brackish intertidal marsh within Suisun Marsh is expected to reduce the adverse effects of stressors related to food and habitat availability for the covered species by:

- increasing rearing habitat area for Chinook salmon, Sacramento splittail, and possibly steelhead (Healey 1991, Siegel 2007);
- increasing the local production of food for rearing salmonids, splittail, and other covered species (Kjelson et al. 1982). Suisun Marsh is located in an area of the estuary that has high production of phytoplankton, zooplankton, and macroinvertebrates;
- providing an important linkage between current and future upstream restored habitat, such as Yolo Bypass/Cache Slough, with downstream habitat, such as Suisun Bay. Suisun Marsh is located in the low salinity zone of the estuary, which serves as a corridor for upstream and downstream passage by migratory fish such as sturgeon and salmonids;

- increasing the availability and production of food in Suisun Bay for delta and longfin smelt by exporting organic material via tidal flow from the marsh plain and phytoplankton, zooplankton, and other organisms produced in intertidal channels into the Bay;
- locally providing areas of cool water refugia for delta smelt (C. Enright pers. comm.);
- reducing periodic low dissolved oxygen events associated with the discharge of waters from lands managed as seasonal freshwater wetlands that would be restored as brackish intertidal marsh (Siegel 2007, C. Enright pers. comm.);
- increasing the extent of habitat available for colonization by Suisun marsh aster and soft-bird's beak; and
- enhancing and increasing the extent of salt marsh harvest mouse and Suisun shrew habitat.

Adaptive management considerations: The adaptive management program will assess the value of restored marshes and adjacent shallow subtidal habitats to covered species habitat, including the capacity of the restored areas to produce food and organic carbon to support food web processes. Results of monitoring the development of early marsh restorations will help inform the design and management of subsequent marsh restoration projects. In addition, monitoring results will also support the development of more cost effective management techniques, if needed, to control the establishment of non-native species in restored marshes.

Conservation Measures for Channel Margin Habitat: HRCM##. Enhance channel margin habitats along not more than 20 linear miles of Delta channel banks. The BDCP will provide for the enhancement of 20 linear miles of channel margin habitat in the Delta. This conservation measure is directed at improving habitat conditions for covered fish species along Delta channel banks (as measured along one bank line of channels) by improving channel geometry and restoring riparian, marsh, and mudflat habitats along levees. Channel margin will be improved only along channels that serve as important rearing habitat and movement corridors for salmonids. Although channel margin enhancements are primarily intended to provide specific benefits to salmonids, enhancement of these habitat is also expected to improve spawning and rearing habitat conditions for Sacramento splittail. This measure will be implemented along non-Project levees within the BDCP Planning Area and along Project levees along the San Joaquin River from Vernalis and Mossdale and along Steamboat and Sutter Sloughs. Actions on Project levees will be carried out in coordination with USACE, consistent with floodplain restoration measures.

Channel Margin Habitat Enhancement Concepts. Channel margin habitats are located adjacent to the bank lines of Delta channels and sloughs at elevations from the mean higher high water tide elevation to 6 feet below the mean lower low water tide elevation. Channel margin habitats will be enhanced to provide the following ecological benefits for covered fish species (see Appendix X, *DRERIP evaluations*):

- increased production of phytoplankton, zooplankton, and macroinvertebrates that serve as or support production food for covered fish species;

- increased availability of Sacramento splittail spawning habitat and splittail and salmonid rearing habitat;
- increased inputs of allochthonous material (e.g., twigs, leaf litter) into Delta waterways in support food web processes;
- improved instream fish habitat structure and associated hydrodynamic complexity;
- improved diurnal water temperatures at a local scale; and
- increased habitat for Delta mudwort and Mason's lilaeopsis where channel margin habitat is restored within the range of each of these species.

Riparian and emergent vegetation that is restored as a component of channel margin habitat enhancements will support habitat for riparian-associated covered wildlife and plant species including (see Appendix X, *DRERIP evaluations*):

- Willow-dominated riparian scrub to increase habitat for riparian brush rabbit, riparian woodrat, and nesting habitat for white-tailed kite;
- Riparian woodland and scrub to increase nesting habitat for Swainson's hawk, white-tailed kite, and yellow-breasted chat;
- Increased habitat for elderberry longhorn beetle; and
- Increased habitat for Suisun Marsh aster where riparian and emergent vegetation is restored within the range the species.

In suitable locations, enhanced channel margin habitats will be designed to provide substrate conditions that support habitat for tidal mudflat-associated covered plant species.

Methods used to enhance channel margin habitats will vary, depending on site conditions. Channel geometry may be modified, where such actions would be consistent with flood control requirements, to improve subtidal aquatic habitat and hydrodynamic conditions by creating low benches that support emergent vegetation and higher elevation benches that support riparian vegetation. Designs with varying width and surface elevations along constructed benches would create hydrodynamic complexity and provide an ecological gradient of habitat conditions. Large woody material (e.g., tree trunks and stumps) could be anchored into constructed low benches or into existing riprapped levees to provide similar habitat functions.

Restoration variables that will be considered in the design of enhanced channel margin habitat include the:

- spatial distribution and extent within the Delta;
- length of habitat restored along channel margins;
- cross sectional profile of enhanced channels (elevation of habitat, topographic diversity, width, variability in edge and bench surfaces, depth, and slope);
- amount and distribution of installed woody debris along enhanced channel margins; and
- extent of shaded riverine aquatic overstory and understory vegetative cover needed to provide future input of large woody debris.

Enhanced channel margin habitats would be designed to support habitat for the covered species listed in Table 3.6. Enhancement design considerations for channel margin habitat include:

- enhancing channel margin habitats in important rearing areas and movement corridors for covered fish species;
- locating and configuring enhanced habitat areas to connect to existing patches of high value covered fish species habitats and to connect disconnected patches of high value habitats.
- incorporating large woody debris into channel banks to improve the structural complexity of existing channel margin habitats;
- providing a gradient of habitat and hydrodynamic conditions to benefit natives and minimize the colonization of non-native submerged aquatic vegetation and use by predatory fish; and
- restoring native woody riparian vegetation to create overhead cover and instream cover to reduce predation risk for vulnerable life stages of covered fish species and to provide nesting and cover habitat for riparian-associated wildlife species.

Distribution of Channel Margin Enhancement. Channel margin enhancement actions will be conducted along both Project levees and non-Project levees in the Planning Area.

- **HRCM15: Enhance channel margin habitats along non-Project levees in the Delta to improve habitat conditions for covered fish species.** The BDCP Implementing Entity will enhance channel margin habitat along non-Project levees in the Delta. This conservation measure is directed at improving habitat conditions for covered fish species along channel banks (as measured along one bank line of channels). Channel margin will be improved only along channels that serve as important rearing habitat and movement corridors for salmonids. Although channel margin enhancements would be located to provide specific benefits to salmonids, enhanced habitats are also expected to improve spawning and rearing habitat conditions for Sacramento splittail.

- **HRCM12: Enhance channel margin habitats along Steamboat and Sutter Sloughs to improve habitat conditions for covered fish species.** Steamboat and Sutter Sloughs are thought to serve as important rearing habitat and movement corridors for juvenile salmonids outmigrating from the Sacramento River (J. Burau pers. comm.). The purpose of this measure is to improve the growth and survival of juvenile salmonids that use these habitat areas. The BDCP Implementing Entity would coordinate planning with the U.S. Army Corps of Engineers to assess the feasibility of making modifications to the slough channels and adjacent Project levees while maintaining the flood control functions of these channels. This measure would be implemented by BDCP if results of planning studies indicate that restoring channel margin habitats along these sloughs is desirable and feasible.

- **HRCM13: Enhance channel margin habitats along the San Joaquin River between Vernalis and Mossdale to improve habitat conditions for covered fish species.** Habitat conditions for covered fish species would be enhanced along the San Joaquin River from Vernalis to Mossdale. The purpose of this measure is to improve rearing habitat conditions for juvenile salmonids and to improve spawning habitat and rearing

habitat conditions for Sacramento splittail. The BDCP Implementing Entity would coordinate planning with the U.S. Army Corps of Engineers to assess the feasibility of making modifications to the slough channels and adjacent Project levees while maintaining the flood control functions of these channels. This measure would be implemented by BDCP if results of planning studies indicate that restoring channel margin habitats along these sloughs is desirable and feasible.

Design elements for channel margin enhancement could include:

- modifying channel geometry to improve hydrodynamic and structural complexity (e.g., construction of low in-channel benches) and to create low velocity habitat areas designed to provide spawning habitat for splittail and rearing habitat for splittail and salmonids;
- establishing emergent and woody riparian vegetation along modified banks that do not support emergent and woody riparian vegetation to provide shaded riverine aquatic and instream cover for covered fish species;
- installing large woody material in banks to improve instream structure and hydrodynamic diversity; and
- controlling the abundance of non-native fish predators and competitors.

To enhance channel margin habitats, the BDCP Implementing Entity would coordinate with and receive approvals as appropriate from the Central Valley Flood Protection Board, California Department of Water Resources, and U.S. Army Corps of Engineers to modify channel characteristics along leveed waterways.

Problem Statement - General: Primary Delta channels serve as movement corridors for the covered fish species and support splittail spawning and salmonid and splittail rearing habitat. These channels are now leveed and, as such, channel margin habitats lack the diversity and complexity of habitat conditions associated with unmodified channels.

Hypotheses: Enhancement of channel margin habitats along important salmonid use areas is expected to reduce the adverse effects of stressors related to habitat and food availability by (see Appendix X, *DRERIP Evaluations*):

- increasing the extent of shaded riverine aquatic cover and increasing instream cover by through contributions of instream woody material (U.S. Fish and Wildlife Service 2004);
- providing inputs of organic material (e.g., leave and twig drop) in support of aquatic foodweb processes;
- increased production and export of terrestrial invertebrates into the aquatic ecosystem (Nakano S. and M. Murakami 2001);
- creating additional spawning habitat for Sacramento splittail by creating low velocity backwater habitats (Sommer et al. 2001a, 2002, 2007, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006); and
- depending on location, increasing the quality of rearing habitat area for Sacramento River salmonids (J. Burau pers. comm., Siegel 2007) and for San Joaquin Basin runs

of Chinook salmon and possibly steelhead (Sommer et al.2001a,b, 2002, 2007, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006).

Problem Statement – Steamboat and Sutter Sloughs: Steamboat and Sutter Sloughs are thought to serve as important rearing habitat and movement corridors for juvenile salmonids outmigrating from the Sacramento River (J. Burau pers. comm.). Preliminary evidence indicates that juvenile salmonids enter these sloughs in proposition to the amount of water entering these sloughs (Perry and Skalski 2008). Hydrodynamic modeling indicates that, depending on multiple factors (e.g., total flows and DCC gate position), up to 80% of Sacramento River water can move through these two sloughs (A. Munevar pers. comm.). If verified with future research, this indicates that up to 80% of outmigrating juvenile salmonids may enter these sloughs. Preliminary evidence suggests that survival of salmonids in these sloughs is lower or equal to that of the mainstem river (Perry and Skalski 2008), likely due to greater predation populations relative to the mainstem Sacramento River. Therefore, improving the habitat conditions in Sutter and Steamboat Sloughs could improve survival, and possibly growth, of outmigrating juvenile salmonids that use these habitat areas.

Hypotheses: Enhancing Steamboat and Sutter Sloughs as fish migration corridors is expected to increase the survival and growth of outmigrating Sacramento River salmonids by:

- increasing the quality of rearing habitat area for Sacramento River salmonids (Siegel 2007, J. Burau pers. comm.);
- reducing the risk for predation on covered fish species by non-native fish predators (J. Burau pers. comm.);
- providing inputs of organic material (e.g., leave and twig drop) in support of aquatic foodweb processes; and
- reducing the risk for entrainment of juvenile salmonids by providing a migration corridor that bypasses the intakes of a new north Delta diversion point, the Delta Cross Channel, and Georgiana Slough.

Problem Statement – San Joaquin River: The San Joaquin River from Vernalis to Mossdale is an important movement corridor for juvenile salmonids outmigrating from the San Joaquin River. This reach of river is also thought to be an important spawning habitat for San Joaquin River salmonids during drier years when floodplains do not inundate. However, much of the channel margin habitat in this reach has been eliminated.

Hypotheses: Enhancing channel margin habitat conditions along the San Joaquin River from Vernalis to Mossdale is expected to reduce the adverse effects of stressors related to food and habitat availability for the covered fish species by:

- creating additional rearing habitat for San Joaquin Basin runs of Chinook salmon, Sacramento splittail, and possibly steelhead (Sommer et al.2001a,b, 2002, 2007, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006);

- creating additional spawning habitat for Sacramento splittail by creating low velocity backwater habitats (Sommer et al. 2001a, 2002, 2007, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006);
- increasing the extent of shaded riverine aquatic cover and increasing instream cover by through contributions of instream woody material (U.S. Fish and Wildlife Service 2004);
- providing inputs of organic material (e.g., leave and twig drop) in support of aquatic foodweb processes;
- increasing production and export of terrestrial invertebrates into the aquatic ecosystem (Nakano and Murakami 2001);
- improving connectivity with upstream habitat areas, including existing and future restored habitats; and
- increasing habitat for Swainson's hawk, riparian brush rabbit, valley elderberry longhorn beetle, delta button celery, and delta tule pea.

Adaptive management considerations: Opportunities for adaptive management include adjusting the design of subsequent channel margin restoration actions to improve habitat functions for covered fish species if indicated by monitoring data. Implementation of this conservation measure would also afford the opportunity to test fish predator control techniques to identify the most efficacious methods for controlling predator populations.

Conservation Measures for Riparian Habitat: HRCM11/HRCM14: Restore at least 5,000 acres of riparian forest and scrub. The BDCP Implementing Entity will restore a minimum of 5,000 acres of riparian forest and scrub associated with the restoration of tidal and floodplain habitats and channel margin improvements. The following are the temporal targets for riparian restoration:

- 1,300 acres restored within 10 years of plan implementation
- 2,300 acres (cumulative) restored by year 15 of plan implementation
- 5,000 acres (cumulative) restored by year 40 of plan implementation

Riparian Restoration in Restored Floodplains. To the extent consistent with flood control requirements, restored floodplain habitat areas (see WOCML2, HRCM1/HRCM2, HRCM3) will allow for the natural establishment and growth of woody riparian vegetation on portions of restored floodplains that support appropriate soils and hydrology. In bypasses co-managed for habitat and flood control benefits, locations where riparian vegetation is allowed to establish would be limited to areas where the presence of riparian vegetation would not compromise flood control standards or hydraulic capacity of the flood control bypass. The locations of such restored vegetation will be determined in coordination with USACE, DWR, and appropriate local flood control agencies. Riparian habitat would be allowed to naturally establish in floodplain habitat areas that are restored by setting back levees to expand the extent of the floodplain subject to overbank flow. The development of riparian vegetation would be monitored to determine the need for control of non-native vegetation to facilitate the establishment of native riparian vegetation or if restoration success could be improved by plantings of native riparian vegetation.

Riparian Restoration in Restored Tidal Marsh. Woody riparian vegetation will be allowed to naturally reestablish along the upper elevation margins of restored intertidal marsh habitats within ROAs (see HRCM4-8 and 16) where soils and hydrology are suitable, including segments of stream channels that drain into restored marshes. Woody riparian vegetation will be actively established on new levees constructed the BDCP Implementing Entity within ROAs and along channel margins of existing levees (see HRCM12-13 and 15). The BDCP Implementing Entity would design these new levees to incorporate features that would provide for the active and passive establishment of riparian vegetation along low elevation surfaces (e.g., levee benches).

Riparian Restoration on Channel Margins. Woody riparian vegetation will be actively established along channel margins of existing levees (see HRCM12-13 and 15) to enhance covered fish species habitat.

Riparian Habitat Restoration Concepts. Riparian habitats would be restored to provide a range of habitat conditions that provide the following ecological benefits in support of covered species:

- increased availability of Swainson's hawk and white-tailed kite nesting and roosting habitat;
- increased availability of potential future breeding habitat for yellow-breasted chat;
- increased availability of riparian brush rabbit and riparian woodrat habitat;
- increased availability of valley elderberry longhorn beetle habitat;
- increased inputs of organic material and macroinvertebrates into Delta waterways in support of aquatic food web processes;
- enhanced shaded riverine aquatic and instream habitat conditions for covered fish species;
- improved diurnal water temperatures at a local scale along channel margins; and
- improved food production and habitat conditions for covered fish species where restored on BDCP restored floodplain habitats.

Woody riparian vegetation would be expected to naturally establish in areas within restored inundated floodplain habitats and along upper elevation margins of restored freshwater tidal marsh habitats that support suitable hydrology and soils. Riparian vegetation would also be restored through plantings of native riparian trees and shrubs in association with restoration of channel margin habitats. Restored riparian habitats would be designed and managed to provide a range of structural and vegetative conditions to meet the habitat requirements of associated covered species, including:

- riparian woodland with cottonwood, willow, and/or valley oak overstory to provide nesting habitat for Swainson's hawk and white-tailed kite;
- willow-dominated riparian or other riparian scrub with little or no overstory vegetation to provide habitat for yellow-breasted chat; and
- riparian scrub with dense brush and thickets of wild rose, wild grape, blackberry, and open overstory to provide habitat for riparian brush rabbit, riparian woodrat, and Suisun Marsh aster.

Restored inundated floodplain and tidal marsh habitats would be monitored to evaluate the progress of the establishment of riparian vegetation. If necessary, the establishment of non-native invasive plant species would be controlled and native riparian vegetation (e.g., seeds, seedlings, cuttings) would be planted to ensure the establishment of the desired species and structural characteristics. Once established, it is expected that the riparian habitats would be self-sustaining but would be monitored to determine if subsequent management actions may be required to ensure successful regeneration of native species.

Problem Statement: Most existing levees were not designed (e.g., steep banks, rip-rap) to incorporate riparian habitat and have created increased habitat for non-native predatory fish and thus contribute to increased predation losses of covered fish species. A lack of riparian habitat associated with existing and restored tidal aquatic and marsh habitats limits the ecological benefits to fish and wildlife by limiting important ecological gradients and ecosystem functions that a full suite of these habitats would provide.

Hypotheses: Restoration of riparian habitat on existing and new levees and in upland transition zones in association with aquatic and marsh habitats is expected to provide the following ecosystem and covered species benefits (see Appendix X, *DRERIP Evaluations*):

- providing inputs of organic material (e.g., leave and twig drop) resulting in increased production of phytoplankton, zooplankton, and macroinvertebrates that serve as or support production food for covered fish species;
- increasing the extent of shaded riverine aquatic cover and increasing instream cover by through contributions of instream woody material (U.S. Fish and Wildlife Service 2004);
- increased production and export of terrestrial invertebrates into the aquatic ecosystem (Nakano S. and M. Murakami 2001); and
- increasing the extent of valley elderberry longhorn beetle habitat and nesting habitat for Swainson's hawk and yellow breasted chat.

Adaptive management considerations: Opportunities for adaptive management include improving the design and management of restoration actions to provide for the successful establishment, growth, and habitat benefits of restored riparian habitats based on monitoring of the development of previously restored riparian habitats. For example, if the natural establishment and growth of native riparian vegetation is substantially impaired by competition with non-native plants, restoration projects may need to provide for the control of non-native plants or require that riparian plantings be installed to improve restoration success.

Conservation Measures for Floodplain Habitat: HRCM1/HRCM2: Restore 10,000 acres of seasonally inundated floodplain habitat. The BDCP will provide for the restoration at least 10,000 acres of seasonally inundated floodplain habitat within the Planning Area. Because of the long-lead time needed to implement floodplain restoration it is not expected that new floodplain would be restored in the first 10 years of plan implementation. The following are the temporal targets for seasonally inundated floodplain restoration:

- 1,000 acres restored by year 15 of plan implementation.

- 10,000 acres (cumulative) restored by year 40 of plan implementation.

Seasonally Inundated Floodplain Habitat Restoration Concepts. Inundated floodplain habitat would be restored and enhanced to provide the following ecological benefits in support of the covered species (see Appendix X, *DRERIP Evaluations*):

- increased primary and secondary production within inundated floodplains in support of food production for salmonid and Sacramento splittail rearing;
- export of organic carbon and primary and secondary production from floodplains into delta waterways in support of food production for covered species within and downstream of the delta;
- export of allochthonous material into delta waterways in support of food production for covered species within and downstream of the delta;
- substantial increase in high quality splittail spawning and rearing habitat and Chinook salmon (all runs) and steelhead rearing habitat relative to existing in-delta habitat conditions;
- reduction in stranding/poaching losses of adult sturgeon and salmonids by improving movement of adult fish past Fremont weir;
- improved habitat connectivity between upstream and downstream habitats;
- improved survival/escapement of juvenile salmonids by reducing the risk for predation by non-native predatory fish; and
- increasing sources of particulate matter to improve turbidity conditions for delta smelt and longfin smelt in delta waterways.

Floodplain habitats would be restored by setting back levees along existing river channels to reestablish connectivity of historical floodplains with river channels from which connectivity was severed with construction of levees and creating new flood bypasses and water control structures to provide for inundation of bypass floodplains (see conservation measure HRCM17 for a description of the Deep Water Ship Channel Bypass floodplain habitat measure).

Restoration variables that would be considered in the design of restored seasonally inundated floodplain habitat include:

- seasonal timing of inundation,
- interannual frequency of inundation,
- duration of inundation,
- spatial extent of inundation,
- depth of inundation,
- flow velocity,
- connectivity with intertidal marsh and open water habitats,
- accessibility to migrating fish,
- design related to stranding risk and fish passage,

- vegetation type and cover,
- dry season land use (compatible farming practices), and
- topography and slope.

Restored seasonally inundated floodplain habitats would be designed to support habitat for the covered species indicated in Table 3.6. Restoration design considerations for seasonally inundated floodplain habitat include the following.

Hydrodynamic Conditions. To provide preferred habitat conditions in support of Sacramento splittail spawning and juvenile salmonid and Sacramento splittail rearing and food production, restored floodplain habitats would be designed to provide the following attributes:

- shallow water with highly variable depth (approximately 2 feet deep on average);
- adequate hydraulic residence time to promote primary and secondary food production and export and turbidity export (number of days to produce desired food resources); and
- velocities that average about 1.5 feet/sec that are highly variable spatially and temporally.

Floodplain Topography. Where appropriate, the topography of restored and enhanced floodplains would be sculpted to reduce the risk for fish stranding by improving drainage and to provide topographic variability to increase hydrodynamic complexity. Berms may also be constructed to direct flows such that important existing habitat areas for sensitive wildlife and plant species are not inundated during periods the Weir is operated.

Connectivity. To the extent practicable, restored and enhanced inundated floodplains would be located and designed such that flows exiting the floodplain would flow through existing and restored tidal marsh to recreate historical landscape relationships and to provide for connectivity with adjacent uplands that result in transitional habitats and accommodate species movement.

Dry Floodplain Conditions. Restored and enhanced floodplains would be managed for ongoing agricultural uses or to support native wildlife habitats. Farmed floodplains would be managed to minimize the use of persistent herbicides and pesticides that are toxic to aquatic organisms and to provide structure and types of residual crop biomass to provide cover and hydrodynamic complexity for fish and provide sources of organic carbon in support of aquatic food web processes during inundation periods. To the extent consistent with floodplain land uses and flood control requirements, if applicable, woody riparian vegetation would be allowed to naturally establish. Established woody riparian vegetation would support habitat for riparian-associated covered species and provide cover and hydrodynamic complexity for covered fish species during inundation periods. Riparian vegetation would also serve as sources of instream woody material for fish habitat, organic carbon in support of the aquatic food web, and macroinvertebrates (e.g., insects) that provide food for covered fish species.

Distribution of Floodplain Restoration. Seasonal floodplain restoration actions could be conducted along any suitable channels in the north, east, and south Delta. Specific conservation actions could include restoration along the San Joaquin mainstem, Old River, Middle River, and east of the Deep Water Ship Channel affecting both Project and non-Project levees in the Planning Area.

- **HRCM1/HRCM2: Restore seasonally inundated floodplain habitat along the San Joaquin River downstream of Vernalis.** The BDCP Implementing Entity will coordinate floodplain restoration planning and flood control planning with the Central Valley Flood Protection Board, DWR, and USACE to assess the desirability and feasibility for setting back levees along the San Joaquin River downstream of Vernalis to restore seasonally inundated floodplain habitats for covered fish species and provide flood control benefits. If results of planning studies indicate that setting back levees along this reach of the San Joaquin River is desirable and feasible, the BDCP Implementing Entity would enter into a cost sharing agreement with the USACE for project planning and construction and would assist with securing authorization and funding for the project. If authorized and funded, the BDCP Implementing Entity would enter into subsequent agreements with the U.S. Army Corps of Engineers and other appropriate agencies governing levee and floodway maintenance responsibilities. This conservation action would expand the capacity of the existing constricted San Joaquin River downstream of Vernalis by setting back levees, improving access of juvenile fish, such as Chinook salmon and steelhead, to seasonally inundated floodplain habitat. Restored floodplain habitat would be designed and operated to support the physical and biological attributes described above in *Seasonally Inundated Floodplain Habitat Restoration Concepts.*

- **HRCM3: Restore seasonally inundated floodplain habitat along Old and/or Middle Rivers.** The BDCP Implementing Entity will restore seasonally inundated floodplain habitat by setting back non-Project levees along Old River and/or Middle River. Seasonally inundated floodplain habitat would be restored either on Fabian Tract along Old River or on Union Island and Upper Roberts Island along Middle River. The location of restored floodplain habitat would depend on the location and design of the selected conveyance pathway and operations of the through-Delta component of dual conveyance. Floodplain habitat would be restored along section of river that would provide the most species and ecosystem benefits. Restored floodplain habitat would be designed and operated to support the physical and biological attributes described above in *Seasonally Inundated Floodplain Habitat Restoration Concepts.*

- **HRCM17: Assess feasibility of a new flood bypass east of the Sacramento Deep Water Ship Channel to restore seasonally inundated floodplain habitat.** The BDCP Implementing Entity will coordinate flood control planning with the Central Valley Flood Protection Board, Sacramento Area Flood Control Agency, California Department of Water Resources (DWR), and U.S. Army Corps of Engineers to assess the desirability and feasibility for creating a new flood bypass east of the Sacramento Deep Water Ship Channel (see Figure 3.1) adjacent to the east levee of the Sacramento River Deep Water Ship Channel. This new flood bypass (hereafter referred to as the Deep Water Ship Channel Bypass) will restore seasonally inundated floodplain habitats for covered fish species and provide flood control benefits. If results of planning studies indicate that construction of a Deep Water Ship Channel Bypass is desirable and feasible, the BDCP Implementing Entity will enter into a cost sharing agreement with the U.S. Army Corps of Engineers for project planning and construction and will assist with securing Congressional authorization and funding for the project. If authorized and funded, the BDCP Implementing Entity will enter into subsequent agreements with the U.S. Army Corps of Engineers and other appropriate agencies governing bypass operations for

providing joint flood control and ecosystem benefits and maintenance responsibilities. Restored floodplain habitat within the bypass will be designed and operated to support the physical and biological attributes described in Section 3.4.2.1, *Physical Habitat Conservation Concepts*. The operational criteria and adaptive range for a new weir and gates associated with the Deep Water Ship Channel Bypass during the BDCP long-term implementation periods are described in Table 3.5.

Design elements of this conservation measure could include:

- acquisition of lands, in fee-title or through conservation easements, suitable construction of set-back levees and restoration of floodplain habitat and for accommodating future sea level rise;
- setting back levees along the selected river corridor and removing the existing levees or large sections of the existing levees;
- discontinuing farming within the setback levees and allowing riparian vegetation to naturally establish on the floodplain;
- actively establishing riparian habitat where necessary to accelerate formation of habitat for specific covered species;
- re-contouring the restored floodplain surface, if needed, to avoid potential for stranding of juvenile and adult fish following inundation events;
- modifying the channel within the new floodplain reach where practicable to create low velocity areas designed to provide spawning habitat for splittail and rearing habitat for splittail and salmonids; and
- allowing the river channel to meander between the set-back levees through the natural processes of erosion and sedimentation.

Problem Statement: The vast majority of floodplain habitat in the Sacramento/San Joaquin River system has been lost through the construction of levees that have separated the major rivers from their natural floodplains. There is currently no functional floodplain habitat in the lower San Joaquin, Old, or Middle Rivers. Flood control agencies are currently planning modifications to the existing Central Valley flood control system, which provides an opportunity for the BDCP Implementing Entity to coordinate with these agencies to explore the desirability and feasibility for setting back levees along these river reaches for dual purposes: flood management and floodplain restoration.

Hypotheses: Increasing the extent of floodplain habitat by setting back levees along the San Joaquin River downstream of Vernalis and Old and Middle rivers is expected to reduce the adverse effects of stressors related to food and habitat availability for the covered fish species by (see Appendix X, *DRERIP Evaluations*):

- creating additional spawning habitat for Sacramento splittail by expanding floodplain habitat area and providing in-channel spawning habitat by creating backwaters (Sommer et al. 2001a, 2002, 2007, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006)

- creating additional rearing habitat for Sacramento and San Joaquin Basin runs of Chinook salmon, Sacramento splittail, and possibly steelhead (Sommer et al. 2001a,b, 2002, 2007, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006);
- increasing the production of food for rearing salmonids, splittail, and other covered species (Sommer et al. 2001a,b, 2002, 2007, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006);
- increasing the availability and production of food in Delta channels downstream of restored floodplain habitat for delta smelt, longfin smelt, and other covered species by exporting organic material and phytoplankton, zooplankton, and other organisms produced from the inundated floodplain into Delta channels (Mitsch and Gosselink 2000, Moss 2007);
- reduce the risk and exposure to mortality associated with the interior Delta and the Delta Cross Channel and Georgiana Slough of outmigrating juvenile fish (Brandes and McLain 2001, USFWS unpubl. data, J. Burau pers. com.) (HRCM17 only);
- reducing the exposure of outmigrating juvenile fish to entrainment at intakes of the proposed north Delta water diversion facilities by passing juvenile fish into the new bypass upstream of the proposed intake locations (HRCM17 only);
- increasing habitat complexity by allowing the natural establishment and growth of woody riparian vegetation that will provide inputs of large woody debris into the river channel and provide overhead cover;
- improving in-channel habitat complexity along the Old or Middle River corridors would be expected to reduce the predation risk to covered fish species and improve connectivity between San Joaquin River habitats and Delta habitats for passage of juvenile salmonids outmigrating from the San Joaquin River and eastside tributaries; and
- riparian habitats within the new floodplain habitat would be expected increase habitat for Swainson's hawk, riparian brush rabbit, valley elderberry longhorn beetle, delta button celery, and delta tule pea.

Adaptive management considerations: Opportunities for adaptive management include adjusting the design of subsequent in-channel backwater and seasonal floodplain habitat restorations to improve their effectiveness in developing as functional habitat for covered species and to produce food and organic material in support of food web processes. Monitoring the establishment of riparian vegetation would provide information necessary for determining the need to control the establishment of non-native vegetation or plant native vegetation to promote development of native riparian forest and scrub habitats.

3.4.2.3 Terrestrial and Non-tidal Wetland Habitat Conservation Measures

[***Note to Reviewers:*** *Protection, enhancement, and restoration conservation measures for agricultural lands, natural seasonal wetlands, managed seasonal wetlands, non-tidal perennial aquatic, and non-tidal freshwater marsh natural communities are currently being developed by SAIC and the BDCP Terrestrial Resources Subgroup.*]